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AMERICAN METEOROLOGICAL JOURNAL.

A Monthly Review of Meteorology, Medical Climatology and Geography.

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THE AMERICAN

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CURRENT NOTES.

THE coast and geodetic survey, by means of a precise series of levels up the Mississippi river to St. Louis and then across the country to New York, has found that the level of water at the mouth of the river is 40 inches above mean tide at Sandy Hook. It would be interesting to discuss what relation the relative depression off New York would have on the Gulf Stream.

DRYNESS AND ALTITUDE FOR CONSUMPTION.—The physicians seem to be by no means agreed that dryness and altitude are very important for consumption. At the meeting of the American Climatological Association, Dr. A. N. Bell called attention to the fact that there is about the same proportion of deaths from this cause in Colorado as in Florida. Forests are great storehouses of moisture and yet they are salutary. At sea the atmosphere is saturated, and yet from English reports it has been shown that the number of deaths among seamen from consumption is ten times less than among similar numbers on shore, and if compared with men of the same age, the death rate is only one-sixteenth that of landsmen. Moisture is therefore not the most dangerous element in the atmosphere.

THE CLIMATE OF FLORIDA.—J. C. Wilson, M. D., divides the peninsula into four strips or regions, (1.) the Atlantic seaboard, (2) the St. John's river, (3) the elevated pineland forming the watershed of the State, and (4) the gulf coast. The great charac-

teristics of all these regions are mildness and equability. Within a year the railroad has opened up the gulf coast, which possesses special peculiarities. Here is the perfection of warm maritime climate, from Cedar Keys to Punta Rassa. The atmosphere is pure, free from dust, and rich in ozone; the temperature mild and equable; the movement of the air moderate, but continuous. The air is remarkably dry, the rainfall small. The small peninsula terminating in Point Pinellas on Tampa Bay offers especial attractions as a sanitarium. There are no frosts, and no malaria, and the water of the bay is sufficiently warm to permit bathing all the year round.

Dr. Keating thinks the lake region of Florida especially good as a winter health-resort. St. Augustine and Jacksonville are as a rule undesirable for consumptives.

TORNADO PREDICTIONS.

The following we owe to the ANN ARBOR REGISTER. We wish the effort the best of success.

NEW YORK, October 15, 1885.

EDITOR REGISTER:—The attention of Congress is called to the fact that some of the terrible loss of life and property due to tornadoes can be averted. In 1882, Prof. T. B. Maury, asserted what was then the fact, that the prediction of a tornado was a triumph yet to be attained by the science of meteorology. In less than two years from that time some predictions of tornadoes were successfully made by Lieutenant John P. Finley of the Signal Service. The per centage of verified predictions is steadily increased by knowledge of the average conditions preceding each series of tornadoes, thus making the predictions more definite and local with each succeeding year. Already the predictions of safety for the day are effective. Of 3228 predictions unfavorable to tornadoes, made in 1884, 3201 were verified, and of 38 predictions that tornadoes would occur made in April and June, 1884, 18 were verified. Of 19 predictions that tornadoes would occur, made in June and July, 1885, 15 were generally verified. When tornadoes were predicted, in no instance did violent storms fail to occur, either hurricanes, tornadoes, or hail.

The failure of some predictions is doubtless due to inaccurate and insufficient reports from sparsely settled regions. While it is admitted that nothing like absolute control of these phenomena has been attained, yet the above figures clearly justify the presence of tornado signals either of safety or danger at every telegraph station in Kansas, Nebraska, Missouri, Illinois, Iowa, Ohio, Michigan, Wisconsin, Georgia and North

Carolina, especially during April, May, June, July, August and September. It is hoped that Congress will direct the Signal Service to submit estimates of the expense necessary to establish such a system of signals. The cost would be a few thousand dollars for flags or colored discs, and for telegraph service.

WILLIAM A. EDDY,
Tornado Reporter, Signal Service, U. S. Army.

DR. NICHOLSON'S OZONE STUDIES.—No inconsiderable attention has been given to the subject of ozone in Michigan, especially in its relation to sickness. The last number of the JOURNAL contained an article by Dr. Nicholson upon ozone who has devoted much time to its study. In an article published by him in 1880, which gives the results of numerous observations under varied conditions, he showed that the air of pine forests contained less ozone in winter, and more in the summer, than that in the open country; that observations of ozone in the air in the vicinity of charcoal pits, both by night and day, were generally negative. He says in regard to the presence of ozone in dwellings, the results of observations, are generally negative, because of the probable presence of sulphurous acid, and of small particles of smoke, emanating from the combustion of fuel in the house, this interfering with chemical changes in the test necessary to liberate the iodine. The same year Dr. Nicholson contributed an article upon the causative relations of atmospheric conditions to intermittent fever, which was published in the report of the Michigan State Board of Health, for 1880, in which he says of ozone: "If we may believe that other meteorological conditions affect the presence or scarcity of the type of disease under consideration, understanding as we do the important relation oxygen bears to animal life, can we assume that an increase or decrease in the quantity of such an important element of the atmosphere as oxygen in a state of activity can itself exert no modifying influence upon this disease?" In October, November, and December, when fevers were *less* prevalent, there was much more than the average of ozone.

PROFESSOR HAZEN ON THUNDER-STORMS.—The following are his preliminary results as stated in a paper read before the American Association for the Advancement of Science at the meeting for 1884. They are taken from the annual volume of the association:

A study of the storms of May 17–20, 1884, leads to the following conclusions:

1. Hail falls occurred, with relatively low pressure at a storm centre, in the region to the southeast of "Low" and at distances of about 250 miles.

2. Thunder-storms were also mostly in the same direction but at distances, on the average, of 450 miles. In cases where these occurred to the west and northwest of "Low," they were sporadic and of little intensity.

3. In this region the winds were gentle and southerly.

4. In many instances there was a furious gust of wind from the west immediately preceding the storm, an increase of eight and ten times the previous velocity in a few minutes.

5. In a few cases where the barometer was frequently read, it was found to indicate a rather sudden increase in pressure as the storm came up.

6. The intensity was greatly diminished at nightfall and again increased the day following.

7. The velocity at which the storms travelled from west to east, spreading somewhat in a fan shape, was, on May 19, from 10 A. M. to 3 P. M., 37 miles per hour; from 3 P. M. to 10 P. M., 38 miles per hour, while the velocity of "Low" was 23 and 10 miles per hour, respectively.

This seems to show that the relation, if there be one, is with the general disturbance rather than with its centre and that the forces which determine the formation and progress of thunder-storms are in a manner independent of those acting in the "Low" itself.

Is this greater velocity of thunder-storms than of "Low," due to their distance from the centre and a consequent greater circumferential motion?

MEASUREMENTS OF GRAVITY.—This well known problem has recently been attacked by new methods. The old methods of the deviation of a plum-line towards a mountain mass, the torsion-balance and the pendulum are well known, but it is satisfactory to be able to obtain so important a constant as that of gravity by many methods.

Mr. J. H. Poynting, some years ago, studied the effect of having

a large mass under one scale-pan of a fine balance. It should increase the apparent weight of the body by an amount equal to the attration of the mass on that side, or rather the surplus of its attraction on that side. Mr. Poynting's idea was extremely ingenious, but though he used a perturbing mass of upwards of 300 pounds, the disturbance of weight caused was slight and the results subject to serious errors.

A year or two afterward, Herr Ph. v. Jolley tried weighing the same mass when at the same height as the scale-pan, containing his weights, and when suspended 69 feet lower. The weight should be greater in the latter case. He then made a mass of 12,700 pounds under the latter and weighed again. His results were more consistent than Poynting's.

König and Richarz now propose a variation on this which will increase the quantity measured and decrease the sources of error. They propose to place under both scale-pans of a very fine balance a mass of lead of symmetrical form weighing over 200,000 pounds. They will then bore through the mass immediately under the centre of the scale-pans and counterpoise with one weight below the lead, the other above; then reverse. The proposal, from all points of view, is a very promising one.

In various numbers of a German periodical, *Rundschau*, published at Carver, Minnesota, Mr. M. Meinhard, of Troy Grove, Illinois, has published some observations of his own to show a diurnal variation of gravity. He finds, as he says, that his mill, with the same head of water, will do more work at night than in the day time. He has also made the following instrumental test: He took a balance and replaced the weights by a steel spring attached to one pan; then, having counterpoised carefully in a cellar (to avoid temperature variations), he attached a multiplying pointer to the weighted pan and watched the result. This proved to be a variation of a fraction of an inch, having its maximum at about sunset. He considers the observation satisfactory, and, in any case, it can be easily tested by any physicist. From the fact that the maximum is at sunset we do not feel assured that he has eliminated sufficiently the variations of temperature. He would do well to observe the thermometer hourly in his cellar and publish the results.

Review of European Weather for August.—*Barom. pressure.* From the 1st till the 4th there is a maximum in the West and a low pressure in the East over eastern Germany and Russia; but on the 5th there appears also a minimum in the S. W. and another over Holland; this latter disturbance however is dispersed on the 6th after causing considerable precipitation; the minimum in the S. W. taking a N. E. course is situated on the 7th over the North Sea, Britain, Holland, Denmark and Northern Germany. The high pressure has by this time receded to the S. W. while another maximum appears in the East. Traveling easterly the depression has reached (on the 9th) the Baltic shores near Memel, but another minimum now appears on the shores of Ireland where by stormy winds the barometer has fallen to 29.0. After causing severe storm on the Norwegian coast this depression recedes to the north, but another quickly follows and has reached on the 13th the vicinity of Shudesnaes on the southern Norwegian shore; it recedes on the following day to the North, while a high pressure with clear, cool weather appears in the S. W. and spreads on the 15th over Holland, Britain and Germany. A low pressure coming from the West travels rapidly in an easterly direction, and on the 17th is situated near Stockholm, and on the 19th near Copenhagen. At the same time two small minima appear over Italy and a high pressure in the west travels on the 20th to the N. E. (barometer at Uleaburg, Finland, 30.43). The area of low pressure hovers over Holland, and on the 22nd and 23rd over Northern Germany, causing many thunderstorms and precipitation; on the 25th it has reached St. Petersburg, and remains stationary over Finland while the high pressure in the N. E. has traveled to the N. W. Another disturbance in the S. W. causes severe storms on the southern part of the Gulf of Biscay (Biarritz), but on the 30th it joins the low pressure in the N. E., the combined system travelling in a northeasterly direction; on the 31st, however, it is separated into two minima, one of which is central near Stockholm and the other near Kiew, in Russia, causing N. W. winds over Germany, Holland and Denmark, under the influence of which the temperature has fallen in some places as low as 48°.

Temperature: Germany.—Below the mean 1–10, 14–31, above the mean 11–13; maximum on the 7th at Breslau 82°, minimum on the 15th 45° at Kassel. A very cold month.

Valentia, Ireland.—Below the mean 4–6, 10–15, above the mean 1–3, 7–4, 16–31; maximum on the 1st 75°, minimum on the 5th 54°.

Petersburg, Russia.—Below the mean 6–9, 15–18, 24–31, above the mean 1–5, 10–14, 19–23; maximum 79° on the 13th and 14th, minimum 37° on the 29th.

Stockholm, Sweden.—Below the mean 1–9, 14–19, 24–31, above the mean 10–13, 20–23; maximum 70° on the 11th and 12th, minimum 44° on the 27th.

Hoparanda, Lapland.—Below the mean 4–8, 22–23, 25–31, above the mean 1–3, 9–21 and 24; maximum 72° on the 5th, minimum 43° on the 24th. M. Buysman.

Middleburg, Holland.

A Possible Method of Electrical Communication between Vessels at Sea.*—In a paper read before the American Academy of Arts and Sciences (Dec. 11, 1878)[1]. I described a modification of a method of tracing equi-potential lines and surfaces employed by Prof. W. G. Adams[2] and other observers. The chief point of difference lay in the use of a telephone in place of a galvanometer, and in the employment of a rheotome, to interrupt the battery circuit with great rapidity. In this paper I described the following experiment which suggested to my mind the method now proposed as a possible method of communication between vessels at sea.

Take a basin of water, introduce into it, at two widely separated points, the two terminals of a battery-circuit which contains an interrupter making and breaking the circuit very rapidly. Now at two other points touch the water with the terminals of a circuit containing a telephone. A sound will be heard, except when the two telephone terminals touch the water at points where the potential is the same. In this way the equi-potential lines can easily be picked out. Now to apply this to the case of a ship

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*Abstract of Dr. A. G. Bell's paper before the Am. Assoc. for the Adv. of Sci., at the meeting of 1884.

[1]See Proc. of the Amer. Ac. of Arts and Science; also Nature, Vol. XIX, p. 211.

[2]Phil. Mag., Dec. 1875, Vol. L, p. 548.

at sea: suppose one ship to be provided with a dynamo machine generating a powerful current, and let one terminal enter the water at the prow of the ship, and the other be carefully insulated, except at its end, and trailed behind the ship, making connection with the sea at a considerable distance from the vessel; and suppose the current be rapidly made and broken by an interrupter; then the observer on a second vessel provided with similar terminal conductors to the first, but having a telephone instead of a dynamo, will be able to detect the presence of the other vessel even at a considerable distance.

This idea has been tested on a small scale with very promising results. A small boat, containing an interrupter and several cells of Leclanché battery, was moored upon the Potomac River in charge of an assistant. I then proceeded down the river in another boat containing a telephone. The circuits were arranged as described above. At the farthest distance tried—which appeared from the map to be about one mile and a quarter—the sounds produced by the action of the interrupter were distinctly but feebly heard. The experiment was not so successful when tried in salt water. I have hitherto refrained from publishing these ideas, as Prof. John Trowbridge, of Harvard College, communicated to me a year or so ago a very similar method which had occurred to him independently, and which I hoped he would publish. As this has not been done, and as the whole subject appears to me to be of importance, I have, with the permission of Prof. Trowbridge, ventured to bring it before your notice. Prof. Trowbridge proposed to utilize his method as a means of preventing collisions in a fog. He believed that by suitable modifications the officers of a ship might not only be able to detect the presence of an approaching vessel before dangerous proximity had been reached but might also be able to determine its position.

JAPANESE WEATHER.—The annual report of the Imperial Weather Service, noticed elsewhere, enables us to draw some interesting conclusions concerning the weather of that most charming part of the earth's surface—Japan. In its fauna and flora a large part of Japan is semi-tropical. This is due to the great northward current, the Kuro-Siwo, which corresponds in

the Pacific to the better known Gulf Stream of the Atlantic. Opposite about the middle of the great island of Nippon the Kuro-Siwo trends north-eastward, leaving Yesso a cool, and Saghalien an almost sub-arctic, climate.

With general arrangement it would hardly be possible to tell beforehand what Japan's cyclonic circulation would be. From the analogy of our Southern States, we would expect that the cyclones in southern Japan would be few in number and that they would soon strike across the islands and go out to sea. From a similar analogy with our Northern States, we would expect that many more cyclones would cross the northern islands from Mantchouria and Siberia and move eastward or a little north of east.

An examination of the maps shows that these general conclusions are not entirely justified. The cyclones show a decided tendency to come in at the southern end and traverse the group from end to end. In January, 1884, there were eight cyclones noted, of which four crossed the group and the others traversed it lengthwise. There were six anti-cyclones, all confined to the southern half of the group, only one crossing their axis directly. In February there were four cyclones and six anti-cyclones, all showing a marked tendency to pass parallel to the long axis of the group. The same is true of the ten cyclones and seven anti-cyclones of March, and so on for the rest of the year. Occasionally they pass down instead of up the Islands, and sometimes, near the centre of Nippon, they double on their course and go southward.

In general their paths are more uniform, show fewer irregularities in velocity and direction, than in the great expanse of the United States and British Columbia. The velocity must average less than with us, and gales are more common over their course. The most of the cyclones and anti-cyclones come from the China Sea, fewer from the Yellow Sea and Sea of Japan; and rarely the disturbances originate in the Islands.

The lines of a mean pressure have a general tendency to lie parallel to the long axis, the isotherms across it. In the latter the effects of the warm current of the South and the arctic one from the North are distinctly shown in that the southern isotherms are directed a little northward, the northern a little southward, such that if continued they would meet at sea, somewhere to the eastward of Niigata and over the Kuro-Siwo.

As to rainfall, it is to us an unexpected result, that the wettest portion of Japan is on the Sea of Japan at about the middle of the great Island of Nippon. There is a little spot on the coast there, west and a little north of Tokio, where the annual rainfall is more than 100 inches. From this point the rainfall decreases in all directions, except for a fringe of western Kiushiu and Shikoku. The decrease is much the most rapid northward and eastward, and over a large part of Yesso (here called Hokkaido) it is only 30 or 35 inches, or about that of the Northern States across the Mississippi River.

Natural Barometers.—Most of the objects popularly called natural barometers are really nothing but indicators of the variation of moisture in the atmosphere, and not at all indicators of variations of pressure. They are therefore hygroscopes rather than barometers. Of such a character is the Araucarian shell an account of which has been going the rounds of the papers for a year or two. It is the cast off shell of a Chilian crab, which remains white in dry weather, but, on the approach of moist weather, shows small red spots which grow as the moisture increases. By the time rain falls the shell has become entirely red. This is simply a case of the change of color with the change in the amount of moisture absorbed, which is not infrequent and is well known to chemists. The barometric artificial flowers, which were the rage, especially in Paris, some years ago, are made on the same principle. The substances with which they are saturated change color with any change in the amount of moisture they contain.

It is for hygroscopic reasons that the creaking of chairs is a sign of rain. The absorption of moisture increases the size of each part, makes the joints fit more closely and causes a creak when by occupation of the chair the relation of joint and socket is slightly changed. It was by taking advantage of the lengthening and shortening of wood with increase and decrease of moisture in the air that the eccentric Wedgwood made a wooden horse without joints that walked across a room. It was on a wager, the horse was simply provided with a sharp point directed backward on each foot. It was then shut up in a bare room and left undisturbed. When next seen it had advanced head first from one side of the

room to the other. The way it walked was this: with every increase in moisture it increased its length and, being prevented by the sharp points on its feet from going backwards, it advanced its forefeet by a small distance, when the air became drier, it shortened and drew up its hind feet. Thus with every change of moisture it made a small advance, and, given enough time, it could go as far as desired. The same sort of motion may be given to an iron rail, by laying it in the sun on a platform and fastening at each end a spike directed backwards. Each day it will be heated and advance the forward end, each night draw up the hind end. In the course of a summer it will make considerable progress.

A curious natural hygroscope is found in the geometrical nets of certain spiders, and is here also due to expansion and contraction from varying moisture. In this case, however, as in ropes, the absorption of water shortens, and its loss lengthens the spider's cables. A century or so ago it was studied by an entomologist named D'Isjonval, who was so enthusiastic over it that he thought it might serve to regulate the march of armies and the movements of fleets. Indeed he proposed that the appearance of these spiders in spring should be announced by the sound of trumpets. He announced that if the weather is to be stormy (that is wet) the main threads of the nets of these spiders will be too short, if fine weather is approaching, too long. Whenever either happens the spider has to go over his work again and correct it. He is therefore more dependent on weather changes than are human beings. He ought to be a meteorologist and must certainly be industrious.

The soot falls down the chimney just before a rain because it absorbs the more abundant moisture and becomes so heavy that its light attachment to the chimney no longer supports it. The frog comes out on the banks and the toad visits unaccustomed places at the same time because the more abundant moisture keeps their damp surfaces from drying too rapidly. The walls are damp from dew deposited on them and the distant hills look near because the dust settles with the increase of moisture. The air feels close and uncomfortable because the insensible perspiration of the skin is checked. Guitar strings shorten and the pitch is raised for a similar reason, and the ladies crimps and curls are subject to the same variation.

Probably the behavior of animals generally on the approach of rain is due also to a sense of increasing moisture, but this may also be accompanied by other sensations, due to cooling, to change in electric tension, to the rising winds. It may also be due in part to the results of long continued actual observations of the gathering clouds and a knowledge of what has followed previous clouds of the same character,—to experience in short. Their mode of indication is very various. Dogs sleep, the ducks quack, peacocks cry, the hogs are restless and carry bits of straw about, the flies are particularly persistent and bite with unusual vigor, the swallows fly low, the cat combs his whiskers, the fish rise in the stream, the crickets sing more loudly than usual, the tree-toad changes his color, and the ants hastily withdraw the pupas, which have been brought out to the top of the ant-hill to catch the vivifying heat of the direct sun's rays.

Some of the natural barometers, so called, are of still more difficult explanation. It is well known that rheumatic persons feel an approaching storm sometimes before it is visible in the sky. It has been said that each storm area has a ring of rheumatism, but the relation between rheumatism and approaching rain is not easy to trace.

THE DROUTH IN SOUTH ENGLAND.—Mr. C. Leeson Prince of the Observatory, Crowborough, Sussex, makes the following remarks on this subject, under date of September 8. Many years have elapsed since this county was visited by so long and severe a drought during the summer months, while its intensity has been increased by the fact that the rainfall both of 1883 and 1884 had been below the average. Notwithstanding this deficiency, the underground springs have not been exhausted to such an extent as was experienced during the summer of 1884. In consequence of the paucity of wells in this district, the two public springs were scarcely able to supply all wants; nevertheless, they never absolutely failed. It is in a season like the past that the value of stored rainwater is manifested, and ought to give an impulse to the consideration of this important subject.

The following table of the amount of rainfall registered in various parts of the county will be interesting to many, whether for

present information or future reference. Although Crowborough has generally the largest rainfall, yet during the late drought a less quantity has been registered here, with one exception, than at any Station from which I have received a report. The comparatively large quantity which fell at Mayfield in July was owing, for the most part, to a heavy thunder shower on the 5th, which was quite locál, and did not appear to extend beyond that parish and those immediately contiguous, as I was able to watch both its aggregation and dispersion. During the storm 1.34 inches of rain fell, and, if this be subtracted from the total for the month, the remainder would not equal the amount registered at the majority of the other Stations.

The summer of 1869 was very dry in the South of England, and the quantity of rain which I then registered at Uckfield exceeded by 0.17 of an inch only the amount reported by Miss L. Day for the past season.

Upon the whole, the summer of 1885 may be considered to have been the driest in this county during the last fifty years.

The mean temperature of the three months was about equal to the average value. The hottest weather occurred during the fourth week in July. The warmest day was the 26th, when the temperature, about 2 P. M., was 84.1° in the shade, and 90° in the open air. As is usual in dry seasons, there was a remarkable absence of any severe thunder storms.

THE RAINFALL DURING THE LATE SUMMER, AT THE FOLLOWING STATIONS IN SUSSEX.

1885.	June.	July.	Aug.	Total.	Authority.
Newick (Ketches)	0.91	0.29	0.71	1.91	Capt. G. R. Keene, R. N.
Crowborough Observatory	0.94	0.47	0.61	2.01	C. L. Prince.
Winchelsea	1.00	0.56	0.49	2.05	Miss Stileman.
Uckfield	0.82	0.67	0.68	2.17*	Miss L. Day.
Eridge Castle	1.18	0.05	1.06	2.29	Mr Rust
Lamberhurst (Scotney Castle)	1.01	0.53	0.77	2.31	E. Hussey, Esq.
Horsham	1.36	0.16	0.88	2.40	R. Sheppard, Esq.
Maresfield (Forest Lodge)	1.06	0.84	0.67	2.57	Capt Noble, F. R. A. S.
Hastings	1.12	0.58	0.90	2.60	W. Andrews, Esq.
East Grinstead	0.95	0.30	1.39	2.64	W. V. K Stenning, Esq.
Worth (Rectory)	1.04	0.27	1.44	2.75	The Rev. G. W. Banks.
Steyning	1.51	0.86	0.41	2.78	Colonel Ingram.
Ticehurst	1.42	0.54	0.92	2.88	Mr. J. G. Webb.
Worthing	1.41	0.77	0.74	2.92	W. J. Harris, Esq.
Brighton	1.58	0.70	0.70	2.98	Dr. Taaffe.
Warbleton (Rectory)	1.67	0.98	0.46	3.11	The Rev. G. E. Haviland.
Mayfield (Vicarage)	1.02	1.73	0.71	3.46	The Rev. H. T. M. Kirby.
Average for the County	1.17	0.61	0.79	2.57	

*The amount of summer rainfall at Uckfield upon the average of 42 years is 7.03 inches.

Musical Sand.—Professor H. Carrington Bolton, of Trinity College, Hartford,Conn., and Dr. Alexis A. Julien, of Columbia College, New York City, have been making a study of musical sands and gave to the American Association at Philadelphia a summary of their results. The sound is sometimes so loud as to be compared to distant thunder, and can be heard 300 or 400 feet. It is decidedly musical and was represented on a musical staff. The sound sometimes has a hoot-like quality, easily recognized. It is most easily got from the dry sand, a quart or more being confined in a bag and the contents violently struck together.

The acoustic quality is evanescent. Wetting, continued rubbing with dry hands, shaking for a short time in a glass bottle or tin box proved always effectual. When the sound has been once "killed," the restoration of the acoustic quality is uncertain. The musical sand can not be distinguished by the eye, but when its acoustic properties are notable, it gives a tingling sensation to the fingers and even to the toes through the boots.

The sand is known from 74 localities in the United States. It has also been occasionally referred to in literature for a thousand years. An obscure allusion to it is found in the Arabian Nights. Old Chinese chronicles mention sonorous sand occurring in the desert of Lob-Nor, Marco Polo narrates superstitions concerning it, the Emperor Baber refers to a locality in Afghanistan, and many travelers in the east describe hills of moving sand whence issue mysterious noises. The famous *Jebel Nakous*, situated on the east of the Gulf of Suez, has been visited by at least six European and American travelers. By comparing their several descriptions the authors have discovered that they describe not one locality, but two, or possibly three, in the same region. Details of the phenomena reported cannot be given in this abstract; it suffices to say that the dry sand rests on a steep incline and when agitated slides down the slope with a gradually increasing noise variously described, but the loudest tones of which are universally compared to distant thunder.

They gave also particulars of two localities in Afghanistan both known as *Reg Ruwan* or *Rig-i-Rawan*, and of a locality in the desert of Sahara, Africa, where similar phenomena occur.

The following brief chronology of the subject was submitted:

Chronology.

16th Century.	Emperor Baber mentions sonorous sand.
1808.	Dr. Seetzen hears reports of Jabel Nakous.
1810.	Dr. Seetzen visits Jabel Nakous.
1818.	Mr. Gray visits Jabel Nakous.
1823.	Ehrenberg visits Jabel Nakous.
1829.	Ehrenberg publishes his narrative.
1830.	Lieut. Wellstedt visits Jabel Nakous.
1846.	Sir Alex. Burnes visits Rig-i-Rawan.
1850. (?)	Hugh Miller discovers the Eigg locality.
1854.	Kauai described by G. W. Bates.
1855.	Prof. H. A. Ward visits Jabel Nakous (?).
1868.	Prof. E. H. Palmer visits Jabel Nakous.
1870–72.	Capt. Lovett visits Rig-i-Rawan.
1875.	Dr. James Blake examines sand from Kauai.
1876.	Dr. Meyn describes Bornholm.
1882.	H. C. Bolton visits Manchester, Mass., and Eigg, Hebrides, and begins a monograph.

THE SOLAR THERMOMETER.

It seems to be generally thought that the relative intensities of solar radiation are measured by the differences between the temperatures of the solar thermometer (black bulb thermometer in vacuo) and those of the air. This seems to be based upon Newton's law (so called), of the rate of cooling of bodies, which was a mere first hypothesis, now known to be very erroneous. Putting it for the temperature of the cooling body, and t' for that of its inclosure, the rate of cooling by this hypothesis, whatever the temperature of the enclosure, is proportional to $t—t'$. If this were so then $t—t'$ would be a true measure of the relative rates of the cooling of bodies in an inclosure, since the measure and the thing measured would be proportional.

When the solar thermometer, exposed to the direct rays of the sun, has a static temperature, its bulb receives, if the lamp-black coating is a perfect absorber, exactly the same amount of heat

which it loses in cooling, and so, if t—t′ is a true relative measure of the rates of cooling, it is likewise of the rates by which heat is received from the sun, that is, of the intensities of solar radiation. The amount of heat reflected by the two surfaces of the glass inclosure (about one-tenth part) can be regarded as proportional to the whole heat received, and so t—t′ is still a relative measure of the intensities.

But according to the true law of cooling, as determined pretty accurately by Dulong and Petit through a range of 300° C., the rate of cooling is not proportional to t—t′ for different ranges of of its value at the same temperature t′, nor is the same rate of cooling indicated by the same value of t—t′ for different temperatures of the inclosure. By this law, if the temperature of the inclosure is 15° (59° F.) and t—t′=17.5°, the rate of cooling of the body is not half the rate for t—t′=35°, but less, and this half rate takes place with t—t′=18.8°. Hence as the rates of cooling are proportional to the intensities of the solar radiation these values of t—t′ are not relative measures of these intensities. Small ranges of t—t′ give measures too great in comparison with the large ranges, so that the intensities for small values of t—t′ become relatively too great by this erroneous measure.

Again, if with the temperature t′=0, we have for a given intensity of solar radiation t—t′=35°, then by the law of Dulong and Petit, for this same intensity we shall have for a summer temperature of, say 30°, t—t′=28.3° only instead of 35°. Hence, using t—t′ as a measure of the intensity, the same intensity measures about one-fifth less when the air temperature is at 30° than when it is at freezing.

Furthermore, taking an extreme case, if we suppose a solar thermometer to be moved away from the earth's influence, but to be exposed to the sun's rays at the same distance from the sun, we should have t—t′1=80° very nearly, that is, since t′ in this case would be the temperature of space, which is sensibly nothing, the thermometer would stand at a temperature of nearly 100° below zero. But if this thermometer were exposed to the sun's rays on the earth's surface without an atmosphere and with a temperature of the glass inclosure of 0°, we should have t—t′=45°, and hence the same intensity would be measured by 180° in the one case and

by 45° in the other, using t—t′ as a measure of the intensity, as we must according to Newton's law. But it would be useless to extend even Dulong and Petit's law down to very low temperatures, since it is merely an empirical law, holding accurately only within the range of temperature for which the experiments were made from which it was deduced.

It is evident, therefore, that, with such a measure, the intensities at low altitudes of the sun are too great in comparison with those of high altitudes, and that we must get erroneous solar and diathermancy constants from the comparison of these intensities. The effect is to increase the diathermancy constant and to diminish the solar constant. In the comparison, also, of winter and summer observations the effect of this erroneous measure is to make the winter intensities too great in comparison with the summer ones.

Although t—t′ is not a true measure of the intensity, yet this is a function of t—t′ and of t′ which is readily deduced from a simple formula. This formula the writer has given in "The Temperature of the Atmosphere and the Earth's Surface, Professional Paper No. XIII of the Signal Service." By this formula not only the relative, but with a constant in the formula properly determined, also the absolute intensities may be determined from observed values of t and t′. This constant could be readily determined by comparing the indications of the solar thermometer with those of any other actinometer, if it cannot be determined directly with sufficient accuracy. It might also be necessary to have constants determined for each thermometer.

In order that the indications of two or more solar thermometers may give the same intensities and be comparable, it is necessary that the bulbs should be perfect absorbers, or at least that they have the same degree of absorbing power, and also that the vacuums should be very nearly perfect. Although the values of t—t′ in different solar thermometers do not in general differ more than one or two degrees; yet in some cases they are found to differ much more. Of course the relative intensities of the different thermometers, then, are not comparable without a reduction by some determined constant to the same standard.

The differences between the indications of different thermome-

ters were formerly much greater than now. It was discovered by Rev. F. W. Stow several years ago that these differences depended very much upon the heat conducted away from the bulb by the stem, and that the temperatures of the thermometers with large stems were lower than those of thermometers with small stems. This is now remedied by blacking the stems about an inch above the bulbs.

Some interesting experiments have recently been made by Mr. Whipple at the Kew Observatory, having an important bearing upon this subject. The results of these experiments show that the absorbing power of the black bulb is increased and its temperature raised, by a second, and even a third, coating of lamp-black. It is, therefore, important, in order to have the indications of these thermometers comparable, that the bulbs should receive several coatings.

It is usually assumed that the air temperature is the temperature of the glass inclosure of the solar thermometer, but this is not strictly the case unless the inclosure is ventilated. It is likewise assumed that the inclosure is a perfect one, but this is not so if any of the rays from the black bulb pass through the glass into the atmosphere and into space. For in this case the temperature of the bulb, without any solar radiation, would be a little below that of the inclosure, and this would have to be the point from which $t—t'$ is reckoned, so that it may not vanish before the radiation in declining does.

During a clear night the bulb is about 1.5° (2.7° F.) cooler than the air temperature. But perhaps this is because the glass inclosure is cooler by the same amount. This might be ascertained by making the observation with a ventilated inclosure. If in this case the temperature were still below the air temperature it would indicate that some of the rays radiated by the bulb passed through the glass inclosure. WM. FERREL.

DETERMINATION OF AIR TEMPERATURE.

PART II.

The main objection that I have urged against Professor Wild's shelter, namely, that in lower latitudes during the day hours it

gives altogether too high readings, seems to have been accepted by Professor Wild. We do not, however, entirely agree upon the causes for this. Professor Wild, because of the intense insolation in low latitudes, would double board the east and west, as well as south sides. It seems to me that this would be against all correct principles of thermometer exposure, as there would be little or no natural ventilation. Even the open bottom would allow the ascent of heated air currents, and would decrease the effect of any natural horizontal ventilation. From such a shelter we could expect only occasional correct readings, as the air temperature crossed that of the shelter. It seems to me that heat reflected from the louvred east and west sides, and from the atmosphere, would tend to raise the temperature of the nearly closed zinc screen and in addition the nearly stagnant air would tend to assume a higher temperature than that having a good chance for motion through natural ventilation. My first experiments with this shelter were made in October 1883, and consisted of comparisons between it and an open shelter; these experiments showed the Wild shelter frequently reading a degree and more higher than the other. Later, Professor Mielberg of Tiflis, found that the Wild shelter gave at times 2° too high temperature. In July and August of 1884, I had an opportunity to test the relative merits of the Wild, open, and several other styles of shelters. These were erected on a frame which brought the thermometers about twelve feet above sod. The following table gives the mean results of 16 hourly readings from 6 A. M. to 10 P. M. for 20 days. These include all classes of weather, but much greater differences occurred in clear weather.

COMPARISON OF TEMPERATURES IN AN OPEN AND IN A WILD SHELTER BOTH VENTILATED AND UNVENTILATED. JULY 16 TO AUGUST 3, 1884.

Time.	Open.	Wild.		Time.	Open.	Wild.	
		Unvent.	Vent.			Unvent.	Vent.
6	65.6	+.8	.2	14	80.7	.7	+.4
7	67.8	.9	.6	15	81.3	.5	.3
8	70.7	1.1	.4	16	80.3	.4	.1
9	72.8	.9	.5	17	78.6	.4	.0
10	74.8	1.1	.5	18	76.7	.4	.0
11	76.8	.9	.4	19	74.1	.2	.2
12	77.7	1.1	.6	20	72.2	.3	+.2
13	79.3	.8	.2	21	70.8	.4	—.1
				22	70.1	.2	+.2

We see the Wild shelter reading more than a degree higher than the open shelter in the morning; this difference gradually diminished in the afternoon and nearly disappeared at night. I have added the results from the ventilated readings, which show almost an exact agreement with the open shelter. These results are rather surprising, and I have sought to check them by special observations at times when the differences would be the most apparent. For example, on June 11, 1885, I obtained results as follows:

COMPARISON OF TEMPERATURES OF THE SLING THERMOMETER, OPEN AND WILD SHELTERS.

Time.	Sling in Shade.	Shelters.		Time.	Sling in Shade.	Shelters.	
		Open.	Wild.			Open.	Wild.
7:39	62.9°	65.9°	67.8°	8·29	63.9°	65 0°	69.2°
44	63.7	66.1	68.0	34	66 5	67 0	71.2
49	62.9	66 2	68.0	39	——	66.6	70.6
54	62.8	64.9	68.4	44	66.8	67.0	70 2
59	62.7	64.1	68.6	49	——	66.6	69 5
8:04	63 9	64.0	68.7	54	69.2	68.7	70 6
9	64.0	64.6	68 3	59	——	69.3	71.3
14	63.3	66.0	68 8	9:04	68.5	69.0	71.6
19	——	65.4	68 9	9	——	68 6	71.0
24	63 9	66.0	69.2	14	68.8	68.4	70.3
				Mean....	....	66 47	69.51

At 7:39 the sky was clear and there was a calm; between 7.49 and 7:54 a south breeze sprung up which lowered the temperature in the open shelter till at 8:04 it read 4.7° lower than the Wild. The mean of these 20 readings showed the open shelter 3° lower than the other. The sling thermometer was used in the shade of the Wild shelter and I have no doubt that the air there was actually cooler than even in the open shelter. The difference between the sling and open shelter was materially reduced by the wind, and after 8:39 the sling averaged slightly higher than the open shelter. A better proof of the effect of shutting off all ventilation from the south side could hardly be obtained.

In order to ascertain the conditions immediately about the shelters, thermometers were hung on the north side of each. In the case of the Wild shelter the thermometer touched the zinc and there was no ventilation from the south; in the open shelter the instrument

hung in front of the louvred north side, thus giving a good ventilation from all sides. It will be noted that all the conditions, except that of ventilation, were precisely the same in both cases. On July 16 the following results were obtained:

COMPARISON OF TEMPERATURES INSIDE AND OUTSIDE OF SHELTERS.

Time.	Open.		Wild.		Time.	Open.		Wild.	
	In.	Out.	In.	Out.		In.	Out.	In.	Out.
10:15	85.1°	+1.3°	+1.6°	7.1°	10:57	87.6°	+.5°	+1.8°	+6.0°
23	85.0	.8	2.3	7.1	11:08	87.7	.4	1.3	5.5
29	85.1	.6	2.4	6.9	15	87.5	.6	1.9	6.5
33	85.7	.4	2.0	6.5	19	88.6	.6	1.4	5.6
37	86.1	1.1	1.6	7.2	24	88.7	.4	1.1	4.7
43	86.2	.7	1.8	7.4	29	88.6	.6	1.2	5.4
47	85.8	.6	2.2	6.6	34	88.6	.4	1.2	5 7
51	85.9	.9	2.2	6.6	40	88.6	.8	1.4	5.9
					Mean.	86.92	.67	1.71	6.29

Each reading is the mean of two sets, one forward and the next back. The 1st column gives the time; the 2d the temperature inside the open shelter; each of the other columns gives the excess in temperature above that in the 2d column. We find that the temperatures inside and outside of the open shelter are nearly alike, as might be expected, from the nearly similar conditions of ventilation. The temperature on the outside of the other shelter was in one instance 7.4°, and in the mean 6.29° higher than in the open shelter. The air inside of the zinc screen had a tendency to assume its temperature and we find it 1.71° higher than in the open shelter; during these observations the sky was clear and there was a gentle south wind. I have made over 800 sets of special observations on different days under all conditions of wind and weather and they have given the following results; all comparison are with the temperature inside the open shelter. In clear hot weather and in the day time, before 15:00 the north side of the zinc screen attains a temperature four to seven degrees too high, the inside from one to three degrees too high, at times running to over 4°. The sling thermometer in the shade of the open shelter gives a temperature one to three degrees too low. This is a very surprising result and I have taken special pains to assure myself that in the morning a

shade temperature is lower than that of the air in sunshine in the immediate neighborhood. That the temperature of the open shelter is nearly that of the air in sunshine, I have proved by swinging black and bright bulbs in the latter; by applying the constant factor .6 to the readings in the shelter and in sunshine, I have found the same temperature. The black bulb seldom reads more than .7° above the bright in the open shelter and this only in intense insolation.

On clear nights the north side of the zinc screen has a temperature from one to two degrees too low, but since this temperature is nearly always falling, the tendency of the inside air to assume it is just about counterbalanced. I think that, in very still air, the inside temperature will be .1° to .2° too low. The open shelter, on the other hand, lags behind the true air temperature from .1° to .2° as we might expect.

Observations of the wet bulb thermometer are quite difficult to compare. First, the effect of the free ventilation of the open shelter is nearly equaled by the greater dryness and too high reading of the dry in the Wild shelter by day; 2d, at night the Wild shelter gives the higher humidity due to the lower reading of the dry and the lack of ventilation; 3d, the Wild shelter lags behind the open shelter in humidity changes. The mean relative humidity from all the observations made was as follows:

Daytime.		*Night-time.*	
Open.	Wild.	Open.	Wild.
64.4%	63.8	53.0	55.3

It would seem that the free ventilation of the open shelter must always be regarded as a great advantage and if a difference in humidity exists between that and any other shelter with less ventilation, we ought to take the results from the former as the better.

In connection with all the preceding observations there were also observations of a shelter like the open one, with the addition of a smaller wooden shelter inside; the louvres of the latter in no place touched the outside shelter. It will be seen that this arrangement has much less ventilation than the open shelter. The temperature of the double shelter lagged somewhat in the morning, but the most singular circumstance was that this shelter had

a lower reading all the afternoon. We would expect a lagging at all times, and after the hottest part of the day a higher reading in the double shelter. The difference was not more than .4°. The most significant difference was in the relative humidity, which was almost invariably higher than that given by either of the other two.

CONCLUSIONS.

1st. In a calm, air in the morning has generally a higher temperature in sunshine than in shade.

2d. It is possible to obtain the temperature of any spot by the use of the black and bright bulb sling thermometers.

3d. An open shelter, allowing a free natural ventilation and shielding from rain by a slight projection on the inside of each louvre, is calculated to give the best results both of air temperature and humidity.

4th. The Wild shelter gives altogether too high results during the day hours, though entirely satisfactory as to temperature at night.

It should be remembered that the question of the immediate environment of the thermometer, while an important one, is by no means as important as that of the locality where the shelter shall be placed. The observations introduced in this paper have been mostly special ones, to bring out in a marked degree certain features especially affected by conditions of ventilation, insolation, etc.

Average meteorological conditions would greatly diminish the differences between even the most diverse shelters, so that we are possibly in danger of devoting too much time to one question in neglect of the other. The mean temperature in shelters of the most diverse patterns would not differ more than .3° or .4°, while I have found improperly exposed shelters giving errors in the mean annual temperature of 4°, or even 5°, and errors in individual observations running up to 20° In any and all cases it seems to me that a free access of air or perfect natural ventilation is the most important consideration.

H. ALLEN HAZEN.

August 21, 1885.

ON THE RELATIONS OF METEOROLOGY TO YELLOW FEVER.

PART II.

Has the experience of 1853 been borne out in subsequent epidemics?

Although yellow fever existed to a considerable extent in 1854, 1855, and 1858, the next formidable epidemic occurred in 1867.

It is believed that no meteorological records were kept in New Orleans, during that year, so that its climatal features cannot be studied except in a general way from memory. This is a very unsafe reliance in statistical deduction or in any investigation where absolute accuracy is necessary; but from my personal recollection there was much hot, humid weather during the early part of summer, followed by dry northerly winds during September. I very distinctly recollect the frequent occurrence of hot "steaming" rains, alternated with hot sun. Later in the season, during the prevalence of dry winds, the characteristics of a high radiation—*i. e.* hot sun and cool in shade, were so well marked that the instrumental record is unnecessary to prove its existence, but, of course, without the thermometer, no comparison can be made with other years.

The fever reached the maximun, in intensity, about the first of October, and it was about this time that the usual autumnal storm occurred.

Proceeding to the greater epidemic of 1878, we are abundantly supplied with data by the records of the U. S. Signal Service, established in 1871.

The year 1877 was normally healthful and free from yellow fever.

The year 1878 was characterized by the severest epidemic of yellow fever experienced since 1853. The year 1879 was one of the most healthful years in the history of New Orleans, although there occurred a few sporadic cases of yellow fever. Having here three consecutive years so much at variance in their records of mortality and states of general healthfulness, let us compare their climatal characteristics with a view to corroborate the theory of Dr. Barton, as applied to his able analysis of the year 1853.

Considering first the barometric pressure, we find upon examination of the records for the months of May, June, July and

August, that during each of these months the pressure was lower in 1878 than in either of the healthful years, 1877 and 1879; that the averages for the four months were, for 1877, 30.078; for 1878, 29.965; for 1879, 29.985. Thus in the epidemic year the barometric pressure was lower during the months which may be considered as fever-producing, than during the two healthful years; and furthermore, the higher pressure prevailed during the year which was entirely free from yellow fever.

Here is a direct contradiction to the experience of 1853 in regard to atmospheric pressure, and at first view we should dismiss this factor from further consideration.

Next, considering the question of a combination of a high temperature and high humidity, we find that the averages of temperature for these months were, for 1877, 79.16°; for 1878, 81.22°; and for 1879, 78.72°—an average for 1878 of 2.06° over 1877, and 2 5° over 1879.

The average humidity was for 1877, 66.78 per cent., for 1878, 70.85 per cent., and for 1879, 69. per cent.—an excess for 1878 of 4.1 per cent. over 1877, and of 1.85 per cent. over 1879. Here then we find a strict confirmation of Dr. Barton's theory—the records showing that both temperature and humidity were markedly higher for these four months in 1878, than during either of the corresponding periods of 1877 and 1879. Furthermore, that the year 1877, which was absolutely free from yellow fever, had a lower dew-point, though higher temperature, than 1879, the phenomenally healthful year, but the one wherein occurred a number of sporadic cases of yellow fever.

The total numbers of rainy days during these four months, were for 1877, 37; for 1878, 56; and for 1879, 44;—another confirmation, if we accept the conclusion that an increased number of rainy days, (the *amount* of precipitation not considered) is favorable to the augmentation of yellow fever. I do not assert that Dr. Barton made any distinct claim in this direction, but he did, and with great propriety, lay particular stress upon the *character* of the rains—such as are alternated with a hot sun.

In this direction I shall point out that during the month of August, 1879, there were seventeen rainy days—more than during the corresponding month of 1878—but from personal and special

observation, these were remarkably cold rains for the season of the year in this latitude; and were not accompanied by the hot "steaming" weather that in some years characterizes our summer homes. The greater humidity of August, 1879, over that of 1877, was caused by these frequent rains, but it was not a harmful humidity, being associated with a lower temperature.

Referring again to the *terrene* conditions in New Orleans, I am not aware that any extended excavations were made during either of these three years under consideration, or that the state of cleanliness was more marked in one year than another. It is true that early in the spring of 1879 the New Orleans Sanitary Association was organized, and did institute very great improvement in the sanitary condition of the city. But while the healthy condition of the city in 1879 might very properly be attributed, in a measure, to the efforts of this association, no such claim could be made for the year 1877.

Referring to Dr. Barton's record for 1853, we find very frequent reference to the subject of solar and terrestrial radiation, as having a marked influence upon the epidemic of that year. He shows that during the months of July, August and September the line of direct solar heat was remarkably high; and that its rise was coincident with the rise of the fever; that the highest point recorded was 148°, —on August 19th; and in referring to his tables of mortalities we find that the greatest daily mortality occurred three days later; which is certainly more than a coincidence, when we remember that the period of incubation for this disease is generally placed at from three to five days.

Unfortunately this branch of meteorological inquiry has been but little studied here, and we have no records for the years 1877-78-79, which we have been considering. Fortunately the records of the Board of Health from 1872 to 1875 inclusive, under the presidency of the late Dr. C. B. White, contain complete daily records of solar radiation by the black-bulb thermometer. The thermometer was exposed at an elevation of twenty-five feet. Dr. Barton's instrument being situated fifteen feet above the ground, so that the data can very well be compared.

We find that during the months of July, August and September, 1872, the maximum of radiation exceeded 130 degrees on 82 days

of these months, and exceeded 140 degrees on 32 days, the highest being 150 degrees, on August 11th.

In 1873, the degree of radiation exceeded 130 degrees on 61 days, but at no time during the year exceeded 140 degrees.

In 1874, the degree of radiation exceeded 130 degrees on 65 days, but did not at any time exceed 140 degrees.

The averages for the three months were, for 1872, 137.3; for 1873, 130.2; and for 1874, 131.3; being a daily average of 7.1 degrees for 1872 over the year 1873, and of six degrees over 1874.

In 1875, the maximum of radiation exceeded 140 degrees only once, on September 1.

There is such a remarkable departure in the amount of radiation between the years 1872, and the three next following, during the yellow fever period, that we are led to search for some correlation between the meteorological figures and the intensity or other circumstances attending the sporadic fever during these years. An examination of the barometric records for the months of July, August and September does not show any marked departure from the normal pressure. The averages for 1872–73 were a little higher than for 1874. The average temperature was for 1872, 83.26°; for 1873, 81.14; and for 1874, 82.55. The relative humidity was slightly higher in 1873 than in 1872, but was very considerably lower in 1874 than in either of the previous years. The higher average temperature of 1874 was caused by the "heated term," which lasted about twenty days. There was no rain during this hot period, except a light shower, and the dew-point was very low. So there is nothing in these figures to engage attention, except that in 1873, the lines of humidity and temperature were less separated than in either of the other years, and thus more nearly approached "yellow fever weather," considered from the Barton standpoint. We have then only to consider, as having a particular bearing upon the question of yellow fever in this case, the very great difference in the solar radiation of 1872 over the years 1873–74.

In 1872, there were 83 cases of yellow fever, the first case occurring about September 1. The first seventeen cases could not be traced to any source of importation.

In 1873, there were 388 cases of yellow fever, clearly traced to

importation, the first case having resulted fatally on July 8th.

In 1874 there were about twenty cases classed as yellow fever by the Board of Health, but this fever was of very doubtful character, many of the cases being considered as of a malarial type by the attending physicians. Some of the cases contracted the fever at Pascagoula, Miss., and others at Havana, Cuba; notwithstanding which fact, but twenty cases occurred in all.

From a meteorological standpoint alone the sporadic cases of these years are very easily studied superficially, when we note that in 1872, there was a very high radiation and a temperature higher than in 1853, but a lower dew point.

In 1873 there was a low degree of radiation, but a dew point more nearly approaching yellow fever conditions.

In 1874 there was no element favorable to yellow fever growth, except a high temperature. We might, without any very great exercise of the imagination, assign as a sequence of the high radiation of 1872, the apparent indigenous character of the fever of that year.

In 1873 the element of moisture was more favorable to yellow fever, although not in a marked degree, and we find nearly five times as many cases as in the previous year. In 1874, there was no element which we consider essential to yellow fever propagation; and although the fever was imported from two sources, but twenty cases occurred, and some of these complicated with the native malarial fevers.

This latter mentioned fact is in confirmation of a belief of Dr. Barton and others; that yellow fever is only a higher grade of remittent fever, aggravated by an augmentation of the meteorological or other causes, which give rise to the latter. But not desiring to intrude upon the domain of the medical profession, I merely mention the fact, as appearing to furnish a slight confirmation of that theory.

From personal recollection, I am enabled to state that the year 1873 was an exceptional year, meteorologically speaking, in that it was characterized by an early spring, accompanied by a very advanced state of vegetation; but accompanied also by very great and sudden changes of temperature. Even as late as April 10, a white frost was said to have occurred upon the low ground in rear of the

city; but this was probably an error. It was in no sense a "yellow fever" year, considered from our usual standards of observation.

Through the courtesy of Mr. Delano, in charge of the U. S. Signal Station at Shreveport, La., and his assistant, Mr. Hill, I am enabled to consider the question of this relation of climate to yellow fever at Shreveport, where an epidemic of very great severity occurred in 1873. This epidemic commenced about the middle of August, and reached its maximum of daily mortality on the 15th of September.

As the atmospheric conditions for the year do not present any marked departure from other years, I shall consider the months of July, August and September only, as affecting the question of yellow fever. I find the barometric pressure so near the usual value, as to be left out of consideration. The average temperature was lower than the ten-year average for July and August, and but slightly higher for September.

The relative humidity was about equal to the ten-year average for July, but three per cent. higher for August, and three and 4-10 per cent. lower in September; so that the only apparent combination is in the nearness of the lines representing the temperature and humidity. This was a special feature of 1853, 1873 and 1878 in New Orleans. I. H. STATHEM.

NEW ORLEANS, LA.

NOTES ON THE CLIMATE OF DETROIT.

Rev. Geo. Duffield, M. D., was for many years a highly respected Presbyterian pastor in Detroit. Amid the multifarious duties of the pastor of a large church, a philanthropist and an eminent citizen, he found time to keep a meteorological register, with very few lacking observations, from 1839 to 1857. The registers of observations were deposited in the library of the University of Michigan by his sons Rev. Geo. Duffield, D. D., and Samuel P. Duffield, M. D., and as these observations have never been published, except occasional fragments in periodicals, I have condensed a few of their leading features in this paper.

The observations were taken twice a day, at 8 A. M. and 2 P. M.,

until October 1st, 1854, after which date they were taken at the usual three daily hours, viz: 7 A. M., 2 and 9 P. M. There is no account of the instruments employed and for many months the reading of the barometer is not accompanied by that of the attached thermometer. The observations of the thermometer can, however, be compared with themselves and will show the general progress of temperature in the 18 years during which the observations were taken.

The monthly averages are given below. The change from two to three daily observations is indicated by a *. The first could not be compared with the second as the corrections to be applied to reduce one to the other are, so far as I know, unknown for Detroit. The elevation of the station of observation is given as 620 feet "above tide-water at Albany, N. Y."

MEAN TEMPERATURES OF DETROIT FROM DR. DUFFIELD'S RECORDS.

Year.	Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°
1839	....	....	....	....	....	....	74.5	75.9	62.9	59.4	36.9	30.3
1840	21.8	35.9	42.5	54.3	67.1	74.3	75.2	72.8	62.1	54.7	40.5	27.3
1841	28.8	27.3	36.4	48.1	60.0	69.8	74.6	71.1	67.6	60.2	44.6	32.2
1842	31.9	31.8	46.1	53.2	63.5	69.6	73.0	68.6	68.4	53.5	36.2	29.9
1843	30.3	18.9	23.8	49.6	61.7	69.4	77.0	74.7	69.8	46.8	37.0	33.2
1844	29.6	32.5	39.2	61.0	64.7	70.5	75.8	69.8	65.6	49.3	40.2	34.1
1845	32.8	32.5	43.1	52.0	60.3	73.4	76.1	78.6	65.4	54.6	40.1	24.1
1846	33.4	28.5	40.0	56.8	63.4	70.5	76.2	75.5	69.3	50.6	42.4	27.9
1847	20.8	23.5	28.4	45.9	59.5	64.8	73.3	68.2	60.6	46.7	38.3	27.1
1848	28.4	29.7	32.1	46.5	65.4	68.4	68.9	70.8	57.2	47.9	31.3	28.0
1849	18.9	20.6	34.3	49.3	58.5	75.1	78.3	75.2	65.5	52.2	47.2	29.1
1850	32.5	30.3	34.6	47.7	59.1	76.6	80.6	75.3	64.5	50.5	45.7	27.1
1851	30.0	33.8	41.7	49.0	62.3	71.8	73.0	72.2	66.0	51.9	37.0	26.7
1852	24.9	28.2	34.5	44.3	62.8	73.4	77.7	75.9	65.0	60.0	38.2	34.0
1853	30.3	30.0	39.4	52.3	62.8	80.3	78.2	78.5	68.7	51.9	44.2	30.6
1854	24.0	29.8	36.7	45.8	61.2	71.4	80.0	77.3	67.4	*54.6	38.7	27.1
1855	28.6	17.7	31.3	49.4	60.2	63.8	73.1	69.8	65.1	47.2	41.6	28.4
1856	15.3	17.0	32.9	47.6	56.1	70.6	75.9	70.1	60.0	49.7	....	25.0
1857	13.9	32.8	30.3	....	53.7	67.1	....	....	...	48.3	....	....

*At this point came in the change from two to three observations daily.

Of some interest, are the temperatures on the coldest and warmest days in the year and these are given below. The temperatures are given for the regular hours of observation except for those which are starred, when the absolute minimum is given. The other numbers are probably a little higher for the coldest and a little lower for the warmest days than the absolute maximum

and minimum. The coldest morning was January 9, 1856, when the thermometer at 7 stood at —20°. The winter of 1856 was throughout a very cold one and the thermometer stood frequently below zero even at the 2 P. M. observation. The extreme cold of the 9th was preceded by what is characterized as "a fearful storm, the like of which has not been known since 1835. The wind blew a gale from the N. E. and the streets in Detroit were barricaded." All outdoor pursuits were suspended for a day or two.

COLDEST AND WARMEST DAYS FROM DR. DUFFIELD'S RECORD.

Year.	Coldest Day.		Warmest Day.	
	Date.	Temp.	Date.	Temp.
1839	....	....	July 26	95°
1840	Jan. 1	5°	....	..
1840	Jan. 24	5	June 1	92
1841	Jan. 18	—16*	June 11	93
1842	Feb. 20	4	July 19	91
1842	Nov. 29	.....	....	..
1842	Dec. 23	.....	....	..
1843	Feb. 17	—6	June 30	93
1844	Jan. 29	—7*	July 1, 2, 14	90
1845	Feb. 6	5	July 14, 21	97
1845	Dec. 19,20	0	....	..
1846	Feb. 26	—6*	July 10	97
1847	Jan. 8	—7	July 18	88
1847	Dec. 26	0	....	..
1848	Jan. 10	4	June 27	89
1849	Feb. 19	—15	July 10	93
1749	Dec. 30	—1	....	..
1850	Feb. 16	6	July 5, 25	94
1850	Dec. 30	—12*	....	..
1851	Jan. 30	—4	July 15, 26	90
1851	Dec. 17	—5	....	..
1852	Jan. 20	—12	July 8	95
1853	Jan. 26	—1	June 14, 15	96
1854	Feb. 4	—4	July 4, 19	96
1855	Feb. 6	—14	June 28	92
1856	Jan. 9	—20	July 26	96
1857	Jan. 22	—12	....	..

*Absolute minimum.

I have also extracted the accounts of frosts in June, July, and August.

JUNE FROSTS.

June 15th, 1841, white frost at Ft. Dearborn.

June 11th, 1842, heavy white frost.

June 12, 1844, white frost.

June 16th, 1847, white frost.

JULY FROSTS.

July 11th, 1843, frost two miles north of Mt. Clemens.

July 20th, 1843, frost at Detroit.

July 16, 1846, frost at Dearborn and Jackson, and on the River Rouge ice was formed.

AUGUST FROSTS.

August 28th, 1839, frosts in the country.

August 7th, 1840, white frost in the country.

August 1st, 1812, frost in Pontiac.

August 27th and 28th, 1844, frost in the country.

The records of frosts in these months ceased in 1847. Whether this is due to the cessation of the frosts or the inattention of the observer cannot be said, but as frosts are recorded in earlier and later months throughout the rest of the registers, it would seem that at least no destructive frosts occurred in the summer during the remainder of the period of observations.

The rainfall and melted snow seemed to have been taken with especial care, and the following table can be safely compared with other records.

RAINFALL AT DETROIT FROM DR. DUFFIELD'S OVSERVATIONS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1839	...	...	...	...	...	...	...	0.78	3.10	0.87	1.30	0.70
1840	2.21	2.93	2.41	4.96	2.21	3.60	6.11	1.52	4.14	3.66	3.53	2.18
1841	2.00	0.16	3.14	3.51	4.84	1.30	2.46	2.30	5.71	0.61	3.87	4.01
1842	1.48	3.16	5.40	4.57	1.23	1.80	11.15	1.19	3.21	2.24	3.39	2.94
1843	3.04	3.38	2.88	3.16	2.72	4.86	3.50	2.31	3.46	2.62	3.31	3.16
1844	2.96	1.44	5.34	3.59	8.26	7.95	6.19	3.08	1.06	2.23	1.85	1.70
1845	1.76	1.16	4.86	4.83	1.72	2.47	2.82	2.33	2.65	2.45	1.65	0.49
1846	2.81	1.37	2.74	1.13	6.23	7.91	4.79	5.60	7.32	4.57	4.49	3.38
1847	2.90	2.61	0.45	2.87	3.54	3.42	5.82	1.48	2.38	6.95	3.78	1.50
1848	4.62	2.27	2.34	1.64	5.86	2.53	11.38	7.36	7.72	4.22	1.45	6.50
1849	3.95	1.08	4.08	3.64	4.64	5.74	4.82	7.19	0.28	3.87	4.19	1.29
1850	3.29	2.44	6.46	1.24	0.60	4.36	4.45	6.09	3.59	1.49	3.07	3.64
1851	4.11	5.68	1.77	4.63	7.26	3.75	6.24	3.93	4.77	2.79	3.82	3.30
1852	1.88	2.53	4.55	4.83	1.20	4.87	4.93	2.41	6.03	3.94	2.72	6.83
1853	0.88	2.49	3.18	5.93	7.98	2.57	2.23	3.60	2.59	2.57	4.39	1.46
1854	3.16	1.74	3.53	5.41	3.26	3.07	5.10	1.38	8.75	7.09	3.67	2.60
1855	4.54	1.55	4.00	7.39	2.86	11.66	15.01	1.96	5.50	4.39	9.31	3.72
1856	0.90	1.50	0.62	3.39	4.79	14.86	3.57	0.95	3.63	2.49	4.53	3.43
1857	1.68	6.32	0.85	...	7.92	7.44	...	...	...	...	...	...
Avr.	2.68	2.43	3.26	3.92	4.28	5.23	5.92	3.08	4.22	3.28	3.57	2.93

The average for the year was 44.80 inches. No notably heavy rainfalls of brief duration were noted. In July 1855, when the

maximum monthly fall occurred, the rain was well scattered through the month, and there was also a fall of 3.24 inches in five hours on the 20th and of 3.81 inches in seven hours on the 24th.

Though it is not indicated by the monthly amount, the fall of 1853 was so dry as to produce dangerous forest fires. On October 18th the record reads "For the past 10 days the woods have been burning all about Detroit. So dry has been the weather for a long time that immense injury has been sustained by fires extending to barns, houses, stock, etc. The atmosphere in the city is filled with smoke." (Nearly 2 inches of rain fell on the 22nd.)

Of violent storms there is no very notable record. Apparently no tornado visited Detroit in these 18 years, unless the following is a record of one: "1841, July 6, violent rain with thunder, lightning and hail between 1 and 2 P. M. The wind blew a hurricane and blew down several small frame houses."

On January 29, 1842, occurred the rare phenomenon of a winter thunderstorm. There were "heavy showers from 3 to 5, with thunder and lightning."

The record of the auroras is quite full. In a few cases the zodiacal light may have been taken as an aurora borealis. The following is the entire record of auroras.

1839, September 3. Splendid aurora; the auroral rays radiated in all directions to the horizon. In the N. W. and S. E. their color was a rich red. Their clouds covered the sky.

1839, September 16. Auroral light in N. after 9 o'clock.

1840, May 29. Aurora from 9:30 to 11 P. M.

1840, October 19. A rich auroral glow.

1841, July 9. Auroral glow in the N.

1841, July 10. Auroral glow, N. N. W.

1841, July 15. Auroral glow, N.

1841, November 19. Splendid auroras from 7 to 12 P. M. Bright streamers and flashes of various colored light from the N. and extending toward the zenith.

1842, April 14 and 15. Auroral streamers and glow from 9 to 11.

1842, June 5. Auroral streamers at N.

1842, July 3. Auroral glow and streamers from 9 on; a bow of light from S. E. to N. W.

1843, March 5. A pencil of light from the W. resembling a comet; also auroral light.

1843, March 6. A bright pencil of white light about 7 P. M. rose from the W., stretching toward E. S. E. Auroral glow.

1843, March 7. Same pencil and glow.

1843, March 8. Same.

1843, March 11. Pencil, same.

1843, April 5. Auroral glow from 9 P. M.

1847, April 7. A splendid auroral arch from E. to W., rich glow and streamers from 7:30 to 11:30 P. M.

1847, August 15. Aurora.

1848, August 8. Auroral glow.

1849, March 18. Splendid streamers.

1849, April 13. Auroral light from N. N. W. to E. N. E.

1849, May 1. Auroral light reaching the zenith.

1850, April 6. Auroral arch and streamers from 7:30 to 9:30, reaching to 30° and extending from N. N. W. to E.

1850, April 8. Auroral light and streamers.

1850, September 3. Brilliant aurora.

1850, September 6. Same with streamers and corona at 3 A. M.

1851, September 29. Auroral glow about 10 P. M., a little to the west of the zenith, giving a cloud-like appearance to the sky. It commenced with a bright white light in the N. W. and N. E.; soon after it spread upwards into an arch and filled the N. with light. About 10 it had spread over the whole sky, giving it the appearance of a magnificent dome, and waves of light passed from one side to the other.

1852, January 19. Bright auroral arch, 15° to 30°.

1852, February 15. Auroral glow, 30° to 35° altitude at 11 P. M. with waves and streamers of light.

1852, February 18. At 2 A. M., a brilliant auroral arch from W. to E. with strenmers; also at 11 P. M.

1852, February 19. Brilliant aurora, covering half the heavens, from 7 P. M. to midnight with streamers and waves of white and red light.

1852, April 9. Auroral arch.

1852, April 10. Auroral streamers.

1853, January 5. Slight auroral light.

1853, March 6. Auroral light.

1853, June 1. Slight auroral light.

1853, July 12. Auroral light; a belt of white light spanning the heavens from N. E. to S. W, about 10 P. M.

1853, September 1. Auroral light.

1853, September 2. Belt of auroral light.

1853, September 3. Auroral light.

1854, January 23. Auroral light, elevation 15°.

1854, February 15. Auroral glow and streamers at 7:30 P. M.

1854, February 24. Bright auroral light, arch at 7 P. M. at 45° elevation, with streamers shooting through it.

1854, February 27. Auroral arch and streamers.

1854, March 25. Auroral streamers.

1854, March 28. Auroral glow, arch 10° elevation.

1854, April 11. Auroral light at 10 to 11, arch 45°; streamers and waves of light, notwithstanding a bright moon.

1854, April 23. Auroral light, streamers.

1854, April 26. Auroral light from 7 P. M.

1854, April 27. Auroral light, 9 to 10 P. M.

1854, May 21. Auroral glow.

1854, September 26. Auroral arch from W. N. W. to E. N. E. Elevation 33°.

1854, October 16. Auroral glow.

1854, October 17. Auroral glow from N. E. at 7 P. M.

1854, October 18. Auroral arch.

1855, March 9. Auroral arch at 10 P. M., altitude 5°.

1855, March 18. Auroral arch 9–10 P. M., altitude 30°.

1855, April 9. Auroral light, 10–11 P. M.

1855, April 16. Auroral light.

1855, July 9. Auroral glow.

1855, August 15. Aurora. M. W. HARRINGTON.

HERE is a short sermon for the rising generation, which is preached by the Nashville *American:* "Intelligence ennobles work, and work crowns intelligence with honor. The young man who shirks work will never rule others. The young man who selects a vocation because it is easy is already effeminate."

RICHARD FRÈRES' THERMOGRAPH.

Nearly a year ago the writer procured from Richard Frères, of Paris, one of their self-registering thermometers. The clock was wound and the record begun immediately on arrival and has never failed since that time to give entire satisfaction. It depends for its action on the expansion and contraction of an exterior tube filled with alcohol, the free end of which connects with a delicate line inside of a glass case, which makes a pen record on a sheet wrapped around a drum inside of which is placed the clock work. The price was 125 francs. A table is annexed of hourly readings for five and one-half days with the corrections to reduce to a mercurial standard. The table may interest those who are engaged in the study of temperature or studies in which temperature plays a part.

Has any one a thermograph which gives better results?

DESMOND FITZ GERALD.

BROOKLINE, MASS., July 17th, 1885.

HOURLY COMPARISONS BETWEEN MERCURIAL THERMOMETER AND RICHARD FRÈRES' THERMOGRAPH AT CHESTNUT HILL RESERVOIR, BOSTON, MASS.

June 23d, 1885.				June 24th, 1885.				July 8th, 1885.			
Time.	No. 1. Temp	No. 2. Add.	No 3. Sub.	Time.	No. 1. Temp	No. 2. Add.	No. 3 Sub.	Time.	No. 1 Temp	No. 2. Add	No. 3. Sub.
5.20 P.M.	67.0	0.5	....	6.20 P. M.	74.5	....	0.1	8.30 A.M.	76.5	....	....
6.20	66.0	....	....	7.20	67.0	....	....	9.30	79.0	....	0.5
7.20	62.5	....	....	8.20	64.0	0.5	....	10.30	82.0	....	0.1
8.20	57.5	0.5	....	9.20	64.0	0.5	....	11.30	84.5	....	1.0
9.20	56.0	1.0	....	10.20	62.0	0.5	....	12.30 P. M.	85.0	....	0.7
10.20	56.0	1.0	....	11.20	59.0	0.5	....	1.30	87.0	....	0.7
11.20	57.0	1.0	....	June 25.				2.30	88.0	....	0.5
June 24				12.20 A. M.	58.0	0.5	....	3.30	89.5	....	1.0
12.20 A.M.	56.0	0.5	....	1.20	57.0	0.5	....	4.30	90.0	....	0.5
1.20	53.5	1.0	....	2.20	55.0	1.0	....	5.30	88.0	....	1.5
2.20	55.0	1.5	....	3.20	54.0	1.0	....	6.30	81.0	....	2.0
3.20	55.5	1.0	....	4.20	52.5	1.0	....	7.30	75.0	....	1.0
4.20	56.0	0.5	....	5.20	56.5	1.5	....	8.30	74.0	....	0.5
5.20	55.5	1.0	....	6.20	61.5	1.5	....	9.30	70.0	....	0.5
6.20	58.0	1.0	....	7.20	67.0	1.0	....	10.30	70.0	....	....
7.20	60.0	1.0	....	8.20	71.3	0.7	....	11.30	70.0	....	0.5
8.20	63.0	1.0	....	9.20	75.2	....	....	July 9.			
9.20	65.5	0.5	....	10.20	79.0	....	....	12.30 A.M.	70.5	....	....
10.20	68.0	0.5	....	11.20	81.5	....	0.5	1.30	69.5	....	0.5
11.20	70.5	0.5	....	12.20 P. M.	83.0	....	....	2.30	68.0	....	....
12.20 P.M.	73.0	....	....	1.20	84.0	....	0.5	3.30	68.0	....	....
1.20	74.0	0.5	....	2.20	84.0	....	....	4.30	66.5	....	....
2.20	77.0	....	....	3.20	84.5	....	0.5	5.30	68.0	0.5	....
3.30	77.0	....	....	4.20	84.0	....	....	6.30	72.0	0.5	....
4.20	77.0	....	0.5	5.20	82.0	....	....	7.30	76.0	0.5	....
5.20	76.5	.....	....	6.20	78.6	....	0.6	....	....	....	....

[*Table completed on next page.*]

July 9th, 1885.				July 10th, 1885.				July 11th, 1885.			
Time.	No. 1. Temp	No. 2. Add.	No. 3. Sub.	Time.	No. 1. Temp	No. 2. Add.	No. 3. Sub.	Time.	No. 1. Temp	No. 2. Add.	No. 3. Sub.
8.30 A.M.	81.0	....	0.5	8.30 A. M.	77.8	....	0.3	8.30 A. M.	72.8	....	0.3
9.30	86.0	....	0.5	9.30	80.0	....	0.5	9.30	75.2	....	0.2
10.30	89.5	....	1.5	10.30	80.0	....	0.5	10.30	77.0	....	0.5
11.30	91.0	....	1.0	11.30	78.5	0.5	....	11.30	79.0	....	0.5
12.30 P.M.	92.0	....	1.5	12.30 P. M.	80.0	....	0.5	12.30 P. M.	78.0	....	1.0
1.30	92.0	....	1.5	1.30	83.0	....	1.0	1.30	80.0	....	1.0
2.30	91.2	....	1.5	2.30	84.5	....	0.5	2.30	80.0	....	1.0
3.30	90.5	....	1.5	3.30	84.0	....	1.0	3.30	78.0	....	1.5
4.30	89.0	....	2.0	4.30	84.0	....	1.5	4.30	78.0	....	0.5
5.30	76.2	....	1.2	5.30	81.0	....	1.0	5.30	74.0	....	1.0
6.30	69.5	....	0.5	6.30	77.0	....	1.0	....	....	....	....
7.30	68.5	....	0.5	7.30	73.0	....	1.5	....	....	....	....
8.30	68.0	....	0.5	8.30	69.5	....	0.6	....	....	....	....
9.30	69.0	0.5	....	9.30	68.0	....	1.0	....	....	....	....
10.30	69.5	0.5	....	10.30	66.0	....	0.5	....	....	....	....
11.30	71.0	....	....	11.30	65.0	....	1.0	....	....	....	....
July 10.				July 11.				....	....	....	....
12.30 A. M.	71.5	....	....	12.30 A. M.	63.0	....	0.5	....	....	....	....
1.30	70.0	....	....	1.30	63.0	....	....	....	....	....	....
2.30	70.0	....	....	2.30	63.0	....	....	....	....	....	....
3.30	71.0	....	0.5	3.30	62.2	0.2	....	....	....	....	....
4.30	70.5	....	0.5	4.30	62.0	....	0.5	....	....	....	....
5.30	71.0	....	0.5	5.30	63.0	....	....	....	....	....	....
6.30	71.5	....	0.5	6.30	65.8	0.2	....	....	....	....	....
7.30	73.5	....	0.5	7.30	70.0	2.0	....	....	....	....	....

The figures in columns Nos. 2 and 3 are to be added or subtracted respectively from column No. 1 to equal temperature by Mercurial standard,

SELECTED ARTICLES.

SOME ECCENTRICITIES OF OCEAN CURRENTS.

[Abstract of a paper by Mr. A. B. Johnson, of the Light House Board, read before the Washington Philosophical Society.]

The records of the Light House Board show that no less than eleven buoys of various patterns have gone adrift from the waters of the United States and been found at distant points where ocean currents have carried them. Many of these are so fully identified that their precise original station could be indicated. In the case of a few, it has been determined that they were swept from the harbor and bay of New York by the outgoing ice in the winter of 1880-81 when nineteen buoys were carried to sea.

1. In the spring of 1871, a buoy was picked up on the west coast of Ireland.

2. In March, 1871, the Norwegian vessel Vance picked up a buoy in lat. 42° 22′, long. 26° 38′.

3. In February, 1881, a buoy went ashore on one of the cays near Turk's island. This was recognized as a New York buoy.

4. May 17, 1881, the steamer William Dickinson passed a whistling buoy in lat. 29° 46′, long. 77° 38′.

5. In March, 1881, a buoy of the largest size, likewise referred to New York, was found near Bermuda.

6. In February, 1882, a Sandy Hook buoy was found near Bermuda.

7. In February or March, 1882, a buoy was washed ashore at Pendeen Cove, Penzance Bay, England.

8. In the Spring of 1882, the Swedish bark Abraham Lincoln picked up a buoy in lat. 32° 30′, long. 28° 40′.

9. October 22, 1883, a buoy was picked up on the east side of Teneriffe in lat. 28° 21′, long. 16° 15′.

10. October, 1883, a second buoy was picked up fifteen miles from the east coast of Teneriffe.

11. August 20, 1883, the British bark Jane Richardson picked up a buoy in lat. 24° 11′, long. 32° 43′.

All were identified as the property of the United States by letters cast in the plates.

The charted currents of the ocean readily explain the courses and account for the positions of many of these buoys, but others appear anomalous.

The members discussed the paper as follows:

Mr. Jenkins cited an instance of a bell-buoy, carried away from the coast of the United States in 1850, which was seen and heard while adrift, and finally stranded on the southwest coast of Ireland.

Mr. Welling suggested that the phenomena might not be referable to ocean currents exclusively, but in part to wind currents. Mr. Johnson judged from the forms of the buoys that their movements would be controlled more by currents than by winds.

Mr. H. Farquhar and Mr. Jenkins were of opinion that the buoy picked up off Florida might have been carried there by the southward coast current. Mr. Dall concurred, but thought it also possible that it had made the entire circuit of the Sargasso sea.

Mr. Dall, referring to Mr. Welling's suggestion, said that wind and current worked together, and their effects could not be discriminated. The wind does not blow prevailingly in any direction without coercing currents to correspondence.

THE VERIFICATION OF PREDICTIONS.*

Mr. G. K. Gilbert has published (American Meteorological Journal, September, 1884, pp. 166–172) a method of estimating the ratio of skill in predictions of occurrences and non-occurrences of a simple event. Adopting his notation, we have

s = the sum or total number of cases,
o = the number of occurrences,
p = the number of predictions of occurrences,
c = the number of coincidences or verifications,
i = the inference-ratio, or that part of the success which is due to skill and not to chance, and which may be called the *degree of logical connection* between event and prediction.

Since success is proportional to each of the two fractions

$$\frac{c}{o} \text{ and } \frac{c}{p},$$

it may be represented by their product

$$\frac{c^2}{op}.$$

The fraction $\frac{o}{s}$ represents the ratio of random success, and therefore $\frac{op}{s}$ verifications out of p predictions are to be ascribed to chance and must be subtracted throughout. The remainders,

$$o - \frac{op}{s} \text{ and } p - \frac{op}{s},$$

represent fields which chance leaves for science to conquer; and

$$c - \frac{op}{s}$$

represents the portion of each which science has to conquer. Hence

$$i = \frac{c - \frac{op}{s}}{o - \frac{op}{s}} \times \frac{c - \frac{op}{s}}{p - \frac{op}{s}} = \frac{(cs - op)^2}{op(s-o)(s-p)}$$

*Abstract (from the Bulletin of the Washington Phil. Soc.) of a paper read by Mr. M. H. Doolittle of the U. S. Coast Survey Office.

Prof. C. S. Pierce (in *Science*. Nov. 14, 1884, Vol. IV., page 453), deduces the value

$$i = \frac{cs - op}{o\,(s - o)},$$

by a method which refers principally to the proportion of occurrences predicted, and attaches very little importance to the proportion of predictions fulfilled.

In the data cited by Mr. Gilbert from Finley's tornado predictions, $s = 2903$, $o = 51$, p 100, and $c = 28$. By Mr. Gilbert's formula,

$$i = \frac{cs = op}{s\,(o + p - c) - op}$$

he obtains

$$i = .216.$$

Prof. Pierce obtains

$$i = .523.$$

I obtain

$$i = .142.$$

By making s, o, and i constant, and imposing conditions on p and c, we may obtain hypothetical data involving equal skill. Putting $c = p$, I infer that Mr. Finley would have manifested equal skill if he had made no false predictions of tornadoes, and, out of the 51, had predicted 7.35. Mr. Gilbert's formula gives 11.18, and Prof. Pierce's 26.67. Putting $c = o$, I infer that he would also have manifested equal skill if he had included all the 51 tornadoes by making 323.7 predictions. Mr. Gilbert's formula gives 221.5, and Prof. Pierce's 1364.

Mr. Finley's entire success in predicting tornadoes is

$$\frac{c^2}{op} = .154;$$

and since the portion due to skill = .142, we may infer that .923 of this success is due to skill, and only .077 to chance. On the other hand, of his success in predicting the non-occurrence of tornadoes, only .147 is due to skill, and .853 is due to chance.

Prophecy and fulfillment are effects of a common cause. Neither causes the other. The problem, broadly stated, requires a numerical expression for the causal relation between two classes of phenomena either in co-existence or in sequence, when the presence of one corresponds sometimes to the presence and sometimes to the absence of the other, and sometimes both are absent. In case of sequence it is immaterial which is antecedent. The quantities denoted by o and p should therefore be interchangeable.

My formula responds properly to every test proposed by Mr. Gilbert. The value of i increases rapidly with that of c, and slowly with that of

s, diminishes with increase of o or p, and varies between the limits 0 and 1. Skill in making false predictions is indicated by a negative value of $cs - op$; but the same degree of causal relation exists as when equal skill is employed in making true predictions; and a negative value of i can never occur. When s either p or o, $i = \frac{0}{0}$; but the apparent indeterminateness vanishes when we consider that i is the product of two factors, of which one $= 0$ and the other is indeterminate within limits. And the value of i is unaltered when predictions of non-occurrences are substituted for those of occurrences, and *vice versa*. In the latter case write $s - o$ for o, $s - p$ for p, and $s - o - p + c$ for c; and the formula reduces to its original form.

In addition to Mr. Gilbert's tests, two others may be considered. In the case of predictions all falsely reported, we may write $s - p$ for p and $o - c$ for c; and the formula becomes

$$i = \frac{(op - cs)^2}{op\,(s - o)\,(s - p)},$$

with a proper reversal of signs in the quantity under the exponent and no change in the value of i.

If occurrences always appear whenever they are not predicted, and never appear when they are predicted, we put $c = 0$ and $p = s - o$, with the result

$$i = 1;$$

or the logical connection is perfect.

In order that the general formula shall be properly applicable, care must be taken that the predictions are fairly homogeneous in definiteness of time and space. For illustration: if predictions that phenomena will occur in given months are examined indiscriminately with those that they will occur on given days, the result will be manifestly worthless.

It has been proposed to extend the problem so as to include three or more classes of events of which one must happen and only one can happen in any case. It seems clear to me that no single numerical expression can be a proper solution of such a problem. Suppose the three classes of events, A, B, and C. By the method above given A and Not A may be examined; and all instances involving either the prediction or occurrence of A may be excluded and B and C separated. Suppose it thus ascertained that great skill has been shown in discriminating between A and Not A, and little or none in discriminating between B and C. No single numerical expression can comprehend these heterogeneous results.

LITERARY NOTES.

(137) **Practical Hints in regard to West Indian Hurricanes.** Translated from the Spanish by Lieut. George L. Dyer, U. S. N. Issued by the U. S. Hydrographic office, Com'd'r J. R. Bartlett, U. S. N. Hydrographic, No. 77, Washington, 1885. Pamphlet 8vo., 15. pp.

This is the translation of a work by Father Benito Vines, S. J., of Havana, and is issued by the Hydrographic Office in pursuance of its general policy to lessen so far as possible the dangers of navigation. It is a clear, succinct, easily comprehensible resumé of our knowledge of hurricanes, touching only on points which will be of practical value to seamen.

(138). **Bollettino decadico pubblicato per Cura dell' Osservatorio Centrale del Real Collegio Carlo Alberto in Moncalieri.** Societa Meteorologica Italiana. Anno. XIII, 1883-84, No. 11 October, No. 12 November; Anno. XIV, No. 1 December, 4 to each 16 pp. These monthly bulletins contain the reports of the stations of the Italian Meteorological Society, reduced to decades. They include reports on meteors, earthquakes, and the state of Vesuvius, Etna, and Stromboli. The number of stations of all classes is about 250, at 31 of which microseismic (small earthquake vibrations) observations are taken. Father F. Denza is the director of the Central Observatory, Father Maggi editor of the Meteorological, and Professor M. S. de Rossi editor of the Seismic part of the Bollettino decadico.

(139). **Pilot Chart of the North Atlantic Ocean.** Hydrographic Office, Washington. One large sheet monthly. This most excellent series of maps is constantly increasing in value, and since our last notice of it has added another feature of importance. In the September and October numbers the paths of areas of low pressure are entered for the North Atlantic. This adds the West Indies to the regions whose barometric relations the meteorologist is now enabled to study.

Notes on the use of oil at sea still continue in an unbroken stream of increasing volume. A brief and clear statement of the character of tropical cyclones for the use of navigators, and a storm card are also added. The last shows the relations of wind to a storm centre, and the course which should be taken by a vessel when caught in a cyclone. The whole makes a neat and attractive map, highly creditable to the Hydrographic Office.

(140) **Ergebnisse der Meteorologischen Beobachturgen im Jahre, 1884.** Veröffentlicht vom Königlichen Meteorologischen Institute, Preussische Statistik, LXXXII, Berlin, 1884, 4to, 170 pp. 1 map.

This is the official publication of the Prussian Royal Meteorological

Institute. The number of stations reporting is 254, of which 184 are in Prussia, and the rest in the German Empire, except one on Heligoland. This is an increase of 56 over last year's report. The publication contains the observatories of the second, third and fourth classes—or those in which observations are taken two or three times a day. It is issued in the form recommended by the Vienna Meteorological Congress of 1873. The early publications of this series were in the hands of Professor Dove, and were undertaken by the Royal Institute with the volume for 1878.

Among the stations are included Eichberg (elevation 348 meters, 1142 feet) and Schneekoppe (1599 meters, 5246 feet). The daily observations and monthly and annual means are given for each station, and the results for periods are made up. In the appendix are given, among other things, the direction of cirri at Ebersdorf; the wind velocities, in meters per second, at Berlin for each hour; sunshine duration for each day, and summaries, for Rostock; and results of observations at Fort Churchill, from 1811 to 1813. H.

(141) **E. J. Goodwin, M. D, A New Physical Truth,** Evansville, 1885. Pamphlet, 8vo, 32 pp.

This pamphlet is by a thoughtful man whose reading has been extensive, but we think his results, so far as they differ from modern physics, are illusory. The statement of his new truth is "All change depends on the adjustment of force with resistance, without which no force can act, be manifested, correlated, and conserved, whereby particles and aggregates compress to, and repel from, centers, and dynamically act in lines of least resistance."

The meaning of the above "one law of the universe" becomes clear in the course of the author's discussion. The original statement is somewhat nebulous. For instance it is now well recognized that *force* is not necessarily conserved, and we suspect the author here means *energy*, so that he has not yet freed himself from the ambiguity in the common meanings of that much misused word force. He speaks of dynamical action in lines of least resistance; why dynamical? as opposed to static action? If so his statement is erroneous; including static action? if so the word dynamical should be struck out.

In general the author does not seem to have yet got the significant distinction between conservative and non-conservative systems. His conception is that in every action of force we have a conservative system. We think that if he would apply his reasoning to non-conservative systems, he would not be so well satisfied with it. H.

(142) **Monthly Weather Review.** (General Weather Service of the U. S) August, 1884. Prepared under the direction of Gen. W. B. Hazen, Chief Signal Officer, by Lieut. Thomas M. Woodruff, Acting Signal

Officer and Assistant, Washington, 1885; 24 pp; 4 charts. We note fartner improvements in this invaluable monthly report. The areas of low and high barometer are now called "cyclonic" and "anti-cyclonic" areas, and pressures are given both in inches and millimeters. The means of gathering maritime news are being systematized and increased and this part of the *Review* is fuller and more complete. The highest temperature recorded in the shade in August was 108.7° at Dayton, Washington Territory. The highest at that place previously since the establishment of the station was 101.8°. Very heavy rainfalls occurred, in some cases reaching five or six inches in a single day. There are now more than 1,400 tornado observers for the service. During the month they reported 16 tornadoes of which 14 were on the third of the month.
H.

(143) **Hong Kong Observatory**. W. Doberck, Government Astronomer. Weather Reports for January, February and March, 1884. These three reports are publications of the Colony and contain the hourly observations of the usual meteorological elements. Each report is a small folio of six pages. We conclude from the statement on the first page that this observatory also publishes daily a China Coast Meteorological Register giving information concerning the weather on the China Coast, on Luzon, and at Nagasaki and Wladivostock. The observatory is also issuing astronomical publications and is displaying great activity under the direction of Dr. Doberck. H.

(144) **Elmer L. Corthell.** *The Interoceanic Problem and its Scientific Solution.* 8vo, 40 pp, several plates. This is the reprint of an address before the American Association for the the Advancement of Science at its meeting in 1885 at Ann Arbor. It is in hearty support of the ship-railway over the Isthmus of Tehuantepec and will be of interest as a contribution to the literature of this problem. H.

(145) **Meteorological Service, Dominion of Canada.** Monthly Weather Review for July, 1885; also for August, 4to, each 8 pages. Charles Carpmael, Superintendent, Toronto. The usual neat and compact reports of this excellent service. H.

(146) **Imperial Meteorological Observatory, Tokio, Japan.** Monthly summaries and monthly means, for the year 1884, with 41 maps. 8vo, stitched. This is a very interesting and suggestive publication. The text is in parallel columns, Japanese and English (script letters). Each month has a map on tracks of cyclones, one for tracks of anti-cyclones, one for isobars and isotherms, and one for rainfall, the latter so small as to give four to a page. There are besides a weather map and a rainfall map for the year. The work seems to be done with

great care and accuracy and we regret that we can not find anywhere in the pamphlet the name of the responsible head of the service. H.

Boletin del Ministerio de Fomento de la Republica mexicana. Folio Nos. 61-84, July 4 to September 22, 1885, Mexico.

(147) **Los Terremotos de Andalucia.** The report to the Spanish government on the Andalusian earthquakes of late date is continued through the numbers 61 to 71. Together it affords a notable contribution to the study of the subject of earthquakes.

(148) **Observaciones Seismicas.** No. 71. From December 25, 1884 to March 9, 1885, there were 39 days on which shocks were felt. On many days more than one distinct shock was felt, in all, for these 39 days there were 77. The shocks were usually very mild, and occasionally they were only recognized by the seismograph.

(149) **Estudio de las Moreas** de Veracruz, Luis E. Villasenor, C. E., Nos. 73-83. This is an elaborate discussion of the tides of the port of Veracruz with deduction of the coefficients of Laplace. It is accompanied by a map of the vicinity of the port, and four diagrams of the tides at the syzygies and the quadratures. It seems to be a thorough and able discussion of the subject, and to be derived from the author's own observations.

(150) **Los Terremotos de Andalucia.** A lecture delivered before the Geographical Society of Madrid, at their reunion, February 3, 1885, by Don Domingo de Orueta, No. 73.

(151) **Los Terramotos de Malaga y Granada.** Federico de Botella y de Hornas, Nos. 75-79. An interesting account of the earthquakes in districts above named. It is from Madrid.

These numbers also contain the usual hourly meteorological observations, and frequently the daily means from other parts of the Republic. They also contain much of interest to the botanist, pharmacist, planter and tree-grower. H.

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(152) CURRENT REPORTS.

Alabama Weather Service, P. H. Mell, Jr., Director, Auburn, August, 1885, 38 stations.—*Blue Hill Meteorological Observatory,* A. Lawrence Rotch, Proprietor, Willard P. Gerrish, Observer, Readville, Mass., May.—*Carson Observatory,* Chas. W. Friend, Observer, Carson City, Nevada, June, August, September —*Illinois State Board of Agriculture,* Chas. L. Mills Secretary, Springfield, July.—*Indiana Weather Service,* Prof. W. H. Ragan Director, DePauw University, Greencastle, spring, summer.—*Iowa Weather Bulletin,* Prof. Gustavus Heinrichs, Director, advance proof for September. *McGill College Observatory,* C. H. McLeod, Superintendent, Montreal, Canada, August.—*Minnesota Weather Service and Crop Reports,* Prof. Wm. W.

Payne, Director, Northfield, D. R. McGinnis in charge, June, August, September.—*Missouri Weather Service*, A. Ramel, Assistant in charge, Washington University, St. Louis, June, August, September.—*Nashville*, Signal Service Weekly Rainfall Reports, L. N. Jesunofsky, Sergeant Signal Corps, U. S. A.—*Nebraska Weather Service Bulletin and Crop Report*, Prof. Goodwin D. Swezey, Director, Boswell University, Crete, Nebraska, August.—*Bulletin of the New England Meteorological Society*, Prof. W. H. Niles, Institute of Technology, President, Boston, June.—*New York Meteorological Observatory* of the Department of Public Parks, Central Park, N. Y., Daniel Draper, Ph. D., Director, July, August.—*Ohio Meteorological Bureau*, E. H. Mark, Secretary, Columbus, August.—*Tennessee Weather Service*, State Board of Health Bulletin, August.

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